Reduced Order Modeling for Non-equilibrium Radiation Hydrodynamics of Base Flow and Wakes: Enabling Manned Missions to Mars

Completed Technology Project (2015 - 2020)

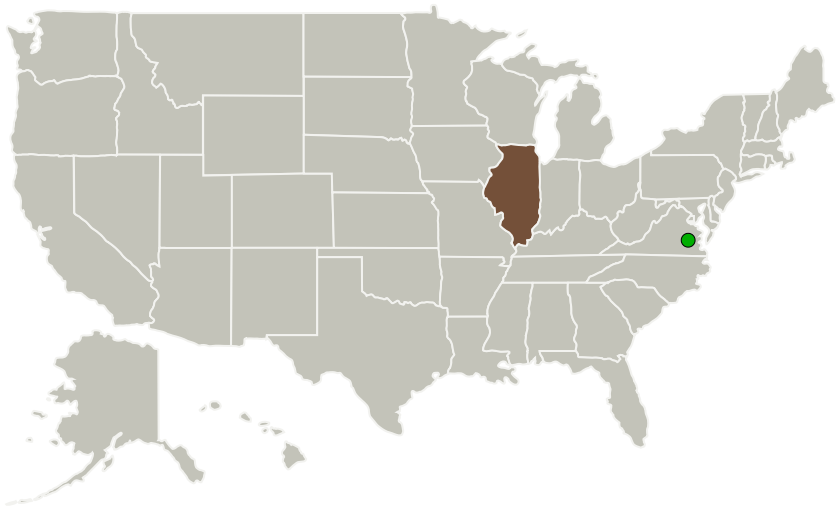
Project Introduction

Understanding non-equilibrium chemical kinetics and its interaction with radiation and fluid mechanics in hypersonic flows remains one of the largest obstacles to the design of light and efficient thermal protection systems for spacecraft. Recent studies identified non-equilibrium radiation as the dominant contributor to after body heating. The prediction of these heating rates is affected by significant uncertainty, which unnecessarily increases the weight of the spacecraft at the expense of scientific payload and aerodynamic stability. The objective of this work is to devise a framework for the construction of reduced order models for chemical kinetics and radiation, relevant to Mars entry applications, based on an adaptive coarse-grained method. The model will enable the description of the strong non-equilibrium kinetics and radiation generated by the recombination of CO2 molecules in the back shell region of entry spacecraft, without the usual reliance on case-specific empiricism.

Anticipated Benefits

The objective of this work is to devise a framework for the construction of reduced order models for chemical kinetics and radiation, relevant to Mars entry applications, based on an adaptive coarse-grained method. The model will enable the description of the strong non-equilibrium kinetics and radiation generated by the recombination of CO2 molecules in the back shell region of entry spacecraft, without the usual reliance on case-specific empiricism.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
University of Illinois at Urbana-Champaign	Lead Organization	Academia	Urbana, Illinois
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations
Illinois

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Illinois at Urbana-Champaign

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

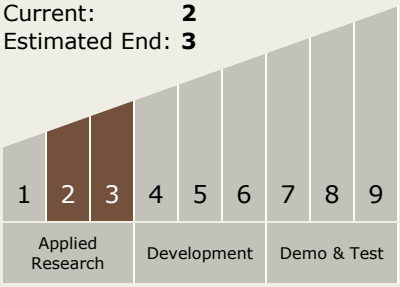
Hung D Nguyen

Principal Investigator:

Marco Panesi

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



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Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Moon, Outside the Solar System